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1878.

IN 1877 a distinct advance was made in telegraphic science by the development of the speaking telephone; but during the past year there have been no less than three notable advances, which reflect honour on the electrical profession, namely, the invention of the microphone, the development of the phonograph, and the introduction of electric lighting. Following upon the speaking telephone of Prof. Bell, the talking phonograph of Mr. Edison was announced as a new and greater marvel at the latter end of 1877; but it was not brought into a practical form until the early part of 1878, when it was exhibited to astonished and admiring audiences in America and England. Although all the magical uses conceived for it in the future by its imaginative inventor may never be realised, we do not doubt that it will ultimately prove serviceable as a vocal signalling appliance as well as a sound repeater, and already it has tended to increase our knowledge of the parts of speech. The phonograph has talked its author into a world-wide fame; and it will ever remain a monument to the strength of his inventive genius.

But public surprise at the phonograph was soon diverted to a third marvel, the microphone. Discovered by Prof. Hughes, in a truly scientific manner, and perfected by him in solitude, its announcement by Mr. W. H. Preece to the Society of Telegraph Engineers took the world by storm. The telephone enables us to speak to distances far beyond the reach of eye or ear, the phonograph renders it possible for us to seal the living speech on brazen tablets, and store it up for any length of time; while it is the peculiar function of the microphone to permit us to hear those minute sounds which are below the range of our ordinary powers of hearing. By these three instruments we have thus received a remarkable extension of the capacities of the human ear, and an accession of dominion over the powers of nature. We have now a command over sound similar in kind to that which we possess over light. For the telephone is for the ear what the telescope is for the eye, the phonograph is for sound what the photograph is for light, and the microphone finds its analogue in the microscope. The carbon microphone used in connection with a battery and an ordinary electro-magnetic receiving telephone, has already proved a practical instrument for sending articulate sounds, with this advantage over a transmitting telephone, that the vocal currents are stronger and not so readily drowned by the induction clamour resulting from messages passing over neighbouring wires. Very soon after the microphone was given unpatented to the world, it was observed by Mr. James Blyth of Edinburgh, and by Professor Hughes himself, that certain forms of the instrument acted as distinct receivers of sounds as well as transmitters, the carbon surfaces in contact being heard to emit audible speech and singing. No practical instrument has resulted from this property as yet, although Prof. Hughes' "hammer and anvil" microphone, mounted on a resonance box, gives very promising effects. The microphone has been utilised in surgery by Sir Henry Thompson in the operation of lithotrity, and by Prof. Rosetti in observing the earth-vibrations which shake Vesuvius previous to irruptions. Professors Houston and Thomson, of Philadelphia, have also applied it as a useful relay for telephone sounds.

The discovery of the microphone was unfortunately marred by one of those controversies as to priority of authorship which sometimes ruffle the serene onflow of science. Mr. Edison, the inventor of the phonograph claimed that the microphone was a plagiarism of his carbon telephone, and preferred a charge of piracy against Prof. Hughes and Mr. W. H. Preece, who, he said, had seen all his experiments while in America in 1876, and had told the microphone secret to Prof. Hughes. A portion of the American press espoused Mr. Edison's side of the affair, and chose to regard Mr. Preece as virtually the thief of the microphone from Mr. Edison, while Prof. Hughes was looked upon as the receiver of the stolen goods. The oddity of a thief who made haste to exhibit his plunder to the public; and of a receiver who freely gave it in turn to the world, did not seem to strike these American writers; but a letter from Sir William Thomson, who was in a certain sense arbiter of the question, charmed away many of the aspersions vented by the American press, aspersions alike unworthy of journalism, and science. Happily the storm has now passed by, and the merits of the case may be calmly studied by those so minded. However it be in America, we may say that in Europe, while Mr. Edison is considered justly entitled to honour as the inventor of the carbon telephone, Prof. Hughes is accepted as the first and true inventor of the microphone, and discoverer of the electric properties of a "bad joint."

More important, in a public and commercial sense, than any of the foregoing inventions, was the appearance of the electric light as a public illuminator in the streets, and at the Universal Exposition, of Paris. The leading mode of lighting there seen

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was the electric candle of M. Paul Jablochkoff, while at some of the railway stations, M. Lontin's system was at work. The wide impulse given to electric lighting by the beautiful display in Paris was soon felt in England, where the Gaiety Theatre was lit by Lontin's system in the latter part of the summer. This introduction of the light into London was followed by the lighting of the *Times* printing and composing rooms, on M. Rapieff's system.

The want of a practical method of sub-dividing the electric light was, however, felt to be a serious stumbling block to its general adoption. On the 4th of October, when public interest in the new illuminator was beginning to rise, Mr. Edison telegraphed to London and Paris that he had solved the problem of sub-dividing the electric light indefinitely; and such was the influence of the inventor's reputation, and the excited state of the financial atmosphere, that a panic in gas shares, from which they have not yet recovered, immediately ensued. The effect on invention in this country was also most marked, and the English Patent Office, for three months afterwards, was charged with patents for subdividing and generating the electric light. Mr. Edison has patented his plan in England, America, and other countries; and is understood to be busy perfecting it and arranging for a public exhibition of it at Menlo Park on an early day. The details are not yet divulged; but it is said that an alloy of platinum-iridium is used as the incandescent light emitter. Grave doubts are reasonably entertained as to the economical success of his system for household purposes, and the gas shares have slowly crept back to a figure more reassuring to holders; but Mr. Edison is reported as being hopeful of his latest invention. Whether he succeed in ousting gas-light from houses and homes remains to be seen; but there can be no doubt that he has made important advances in adapting the electric light for general use. It is certain, at least, that what with the machines of Gramme, Siemens, Brush, de Méritens, and others, and with the candles of Jablochkoff and Wilde, the arcs of Lontin, Rapieff, and Wallace-Farmer, the incandescent carbon lamp of Werdermann, and of Sawyer-Man which we describe in this number, and the incandescent platinum of Edison, the electric light will ere long take the place of gas in streets, factories, warehouses, large halls, galleries, and in shops. There will thus be a permanent gain to the electrical profession as well as to the general public.

Before he engrossed himself with the electric light, Mr. Edison, with his accustomed activity, had invented the micro-tasimeter in which the sensitiveness of the resistance of prepared carbon to pressure is made a means of measuring minute pressures and temperatures. The megaphone, an acoustical rather than an electrical instrument, is the result of his attempt to construct a sensitive ear-trumpet; but although extremely delicate, it is in its present form too clumsy to be serviceable to those afflicted with deafness. The sonorous voltameter, a similar instrument to Bertin's detonating voltameter, invented about the same time, is also a contribution from Mr. Edison during 1878.

New forms of telephones, and telephone calls, new forms of batteries, notably Dr. Byrne's pneumatic battery, in which the current is remarkably increased by pumping air into the liquid, Beaufil's sulphate of mercury conglomerate battery, and Leclanché's conglomerate battery, in which the polariser is made in a lump and affixed to the negative pole, have been constructed. Higgin's improved printing telegraph, Johnson and Phillips' insulator, are also worthy of mention. Nor must we forget the new multiple telegraph instruments of MM. Baudot and Olsen, exhibited at the Paris Exhibition. In pure electrical science, some interesting researches have been made, as, for instance, the investigation of Mr. Spottiswoode on stratified discharges in gases; of Sabine on Selenium; and of Mr. Crookes, on the electric discharge in an exhausted tube, which we give in the present number.

In submarine telegraphy the project for a cable from Aden to the Cape of Good Hope was revived during the past year, with the alternative of a overland line from Khartoum to Pretoria, as advocated by Mr. Seivewright; but no decided steps have been taken to carry out either the one or the other. Arrangements have, however, been made for duplicating the cable communication to Australia, *viâ* the East Indian Islands; and during the year the Eastern Telegraph Company extended their cable system, so as to include the newly acquired island of Cyprus. Duplicate lines were also laid by this company and the Eastern Extension Company. Muirhead's duplex system was also applied to the Madras-Penang section of the latter company, and to the French Atlantic Company. We have reported too that Mr. J. B. Stearns has succeeded in effecting the duplex balance, at Hearts Content, on one of the Anglo-American Atlantic Cables.

1878 has been a fatal year among electrical worthies. While December of 1877 carried off the much respected Ruhmkorff, the succeeding January removed Antoine Cesar Becquerel, the father of electro-chemistry and discoverer of the electro-deposition of metals; and May was marked by the death of Prof. Henry, the venerable Nestor of American science, and discoverer of the self-induction of secondary currents in a closed circuit. In

April died William Orton, the enterprising President of the Western Union Telegraph Company, a man of whom telegraphists may well exclaim, "How are the mighty fallen." Nor should we forget a countryman of our own, whose humbler achievements have yet made his name a familiar one to English electricians—we mean the late Mr. William Hooper.

AN IMPROVED MANGANESE BATTERY.

By M. G. LECLANCHÉ.

IN a note which I communicated in 1876 to the Academy of Sciences, I mentioned that I had succeeded in combining, by hydraulic pressure, certain depolarising mixtures, among others one formed of carbon powder, peroxyde of manganese and gum lac. The electricity of this solid mass was collected simply by a small prism of carbon, three or four centimetres long.

This was embedded during the compression of the agglomerate; the solid mass so formed constituted the electro-negative pole of the cell, while the electro-positive consisted of a simple pencil of zinc; the exciting liquid being a saturated solution of sal-ammoniac. A hundred thousand cells so constructed have been set up for use, partly for telegraph work, and partly for bells of railway signalling instruments.

With regard to their use in telegraphy, I have noticed that they work very regularly for nearly eighteen months, uninterruptedly and without attention; but whenever these batteries have been applied to instruments worked by electro-magnets of low resistance, numerous defects have shown themselves: the electro-chemical work done has never attained 50 per cent. of what it ought theoretically to have done.

In these cells, in proportion to the electrical work accomplished, the peroxyde of manganese, which forms about 40 per cent. of the mass, is reduced to the sesquioxyde, a body which is not absolutely a conductor of electricity; the agglomerate thus becomes more and more resisting, besides which considerable quantities of ammonia accumulate in the pores of the agglomerate, with the inevitable result of disaggregating the latter, whence follows a want of adherence between it and the carbon. The resistance of the cells, which was primarily only about equal to 200 metres of 4 mm. telegraph wire, attains after some months of continuous service, a resistance ten or fifteen times as great.

In telegraphy this defect is not of much importance, the electro-magnets of receiving instruments having an average resistance of about one hundred kilometres; the increase of resistance in the battery being small compared with the total resistance of the line and instruments, the current remains sensibly constant. On the other hand, when the electro-magnets have, relatively, a low resistance, as for example, in railway signal instruments, the increase of resistance in the battery causes variations of current so considerable as to render it inefficacious.

I have succeeded in solving this difficulty by rendering absolutely constant the internal resistance of the cell, whatever the amount of electro-chemical work performed by it.

The resistance of the agglomerate is essentially a function of the conductibility of the mass, and of the adherence of the carbon to this mass. To render it entirely independent of these two conditions, it is sufficient to employ the compressed agglomerate in the form of plates united to a plate of horn carbon, having about half a square decimetre of surface. In this case the resistance of the cell depends only upon the conductibility of the

exciting liquid between the carbon and the zinc This conductibility tends rather to augment than to diminish; in effect, in proportion to the work done, chloride of zinc is formed, which is a very good conductor, and the only variable is the depolarising power of the agglomerate.

This depolarising power is always utilisable and effective, for it is more than sufficient when the agglomerate contains only a few hundredths of peroxyde of manganese. I may say that the reduction is effected to the last atom. The maintenance of elements constructed according to this method is most easy, since it is only necessary, when the cell is worn out, to provide the carbon with fresh depolarising plates.

The old batteries constructed with a mixture of manganese and crushed carbon, contained in a porous vase, or with the cylindrical agglomerates, at present used for igniting platinum wires to fire torpedo fuses, are of somewhat large dimensions. In the construction of my new batteries, I have

been able to diminish their size and weight by one half. By augmenting the number of plates attached to the carbon, the internal resistance may, so to speak, be indefinitely diminished. These cells may remain charged for an indefinite period, the internal action being *nil* when the circuit is not closed. They, therefore, fulfil all the conditions required for firing fuses. The depolarising action is so great, that a mere fragment attached to a polarised carbon plate serves to entirely depolarise it in less than a minute.

For military telegraphy, I have been able to make cells, which although exceedingly small have but a very low resistance.—*L'Eléctricité.*

ON THE ILLUMINATION OF LINES OF MOLECULAR PRESSURE, AND THE TRAJECTORY OF MOLECULES.

By WILLIAM CROOKES, F.R.S., V.P.C.S.

Induction Spark through Rarefied Gases. Dark Space round the Negative Pole.

THE author has examined the dark space which appears round the negative pole of an ordinary vacuum tube when the spark from an induction coil is passed through it. He describes many experiments with different kinds of poles, a varying intensity of spark, and different gases, and arrives at the following propositions.

Illumination of Lines of Molecular Pressure.

a. Setting up an intense molecular vibration in a disc of metal by electrical means causes a molecular disturbance to proceed from the surface of the disc to the surrounding gas. When the gas is dense, the disturbance only extends a short distance from the metal, and, as rarefaction proceeds, the layer of molecular disturbance increases in thickness. In air at a pressure of ·078 millimetres this molecular disturbance extends for at least 8 millimetres from the surface of the disc, forming an oblate spheroid round it.

b. The diameter of this dark space varies with the exhaustion; with the kind of gas in which it is produced; with the temperature of the negative pole; and, in a slight degree, with the intensity of the spark. For the same degree of exhaustion it is greatest in hydrogen and least in carbonic acid, as compared with air.

c The shape and size of this dark space do not vary with the distance separating the poles; or, except very slightly, with alteration of battery power; or with intensity of spark. When the power is great the brilliancy of the rest of the tube overpowers the space, and renders it difficult to observe; but, on careful scrutiny, it is seen to be there unchanged in size. With a very faint spark the space is still present, unaltered in dimensions, although scarcely visible; and if the power is still further diminished, it fades out altogether, without change of shape.

The author describes numerous experiments, devised to ascertain if this visible layer of molecular disturbance is identical with the invisible layer of molecular pressure or stress, the investigation of which has occupied him for some years.

The Electrical Radiometer.

One of these experiments is as follows:—An ordinary radiometer is made, with aluminium discs for vanes, each disc having a film of mica close to one side. Instead of a glass cup, the fly is supported by a hard steel cup, and the needle point on which it works is connected by means of a wire with a platinum terminal sealed into the glass. At the top of the radiometer bulb a second terminal is sealed in. The radiometer can therefore be connected with an induction coil, and the moveable fly be made the negative pole.

Passing over the phenomena observed at low exhaustions, it is found that, when connected with the coil, a halo of a velvety violet light forms on the metallic side of the vanes, the mica side remaining dark throughout these experiments. As the pressure diminishes, a dark space is seen to separate the violet halo from the metal. At a pressure of half a millimetre this dark space extends to the glass, and positive rotation commences.

On continuing the exhaustion, the dark space further widens out and appears to flatten itself against the glass, the rotation now being very rapid.

When aluminium cups are used, instead of discs backed with mica, for the vanes of a radiometer, similar appearances are seen. The velvety violet halo forms over each side of the cup. On increasing the exhaustion the dark space widens out, retaining as much as possible the shape of the cup. The bright margin to the dark space becomes concentrated at the concave side of the cup to a luminous focus, and widens out at the convex side. On further exhaustion, the dark space on the convex side touches the glass, when positive rotation commences, becoming very rapid as the dark space further increases in size, and becomes flattened against the glass.

Convergence of Molecular Rays to a Focus.

The subject next investigated is the convergence of the lines of force to a focus, as observed with the aluminium cup. As this could not be investigated when in rapid rotation, an instrument was made, having the cup-shaped negative pole fixed, instead of moveable. On exhausting, the convergence of the lines of force to a focus at the concave side was well observed. When the dark space is very much larger than the cup, it forms an irregular ellipsoid drawn in towards the focal point. Inside the luminous boundary a focus of dark violet light can be seen converging, and as the rays diverge on the other side of the focus they can be seen spreading beyond the margin of the dark space; the whole appearance is strikingly similar to the rays of the sun reflected from a concave mirror through a foggy atmosphere.

Green Phosphorescent Light of Molecular Impact.

At very high exhaustions the dark space becomes so large that it fills the tube. Careful scrutiny still shows the presence of the dark violet focus, and the part of the glass receiving the rays diverging from this focus shows a sharply defined spot of greenish yellow light. On still further exhaustion, and especially if the cup is made positive, the whole bulb becomes beautifully illuminated with greenish yellow phosphorescent light.

This greenish yellow phosphorescence, characteristic of high exhaustions, is frequently spoken of in the paper. It must be remembered, however, that the particular colour is due to the special kind of soft German glass used. Other kinds of glass phosphoresce of a different colour. The phosphorescence only takes place under the influence of the negative pole. At an exhaustion of four millionths of an atmosphere,* no light other than this is seen in the apparatus. At ·9 M the phosphorescence is about at its maximum. When the exhaustion reaches ·15 M the spark has a

* M signifies the millionth of an atmosphere.

difficulty in passing, and the green light only appears occasionally in flashes. At ·06 M the vacuum is almost non-conductive, and a spark can only be forced through by increasing the intensity of the coil, and well insulating the tube and wires leading to it. Beyond that exhaustion nothing has been observed.

Focus of Molecular Force.

In an apparatus specially constructed for observing the position of the focus, the author found that the focal point of the green phosphorescent light was at the centre of curvature, showing that the molecules causing it are projected in a direction normal to the surface of the pole. Before reaching the best exhaustion for the green light, another focus of blue-violet light is observed; this varies in position, getting further from the pole as the exhaustion increases. In the apparatus described, at an exhaustion of 19·3 M these two foci are seen simultaneously, the green being at the centre of curvature, whilst the blue focus is nearly twice the distance off.

Nature of the Green Phosphorescent Light.

The author adduces the following characteristics of the green phosphorescent light, distinguishing it from the ordinary light observed in vacuum-tubes at lower exhaustions:—

a The green focus cannot be seen in the space of the tube, but only where the projection causing it strikes the glass.

b The position of the positive pole in the tube makes scarcely any difference to the direction and intensity of the lines of force which produce the green light. The positive pole may be placed in the tube either at the extremity opposite the negative pole, it may be below it, or by its side.

c The spectrum of the green light is a continuous one, most of the red and the higher blue rays being absent; whilst the spectrum of the light observed in the tube at lower exhaustions is characteristic of the residual gas. No difference can be detected by spectrum examination in the green light, whether the gas whose residue it is has been nitrogen, hydrogen, or carbonic acid.

d The green phosphoresence commences at a different exhaustion in different gases.

e Viscosity of a gas is almost as persistent a characteristic of individuality as its spectrum appearance. The author refers to a preliminary note and a diagram* of the variation of viscosity of air, hydrogen, and other gases at exhaustions between 240 M and ·1 M. From these and other unpublished results, the author finds that the viscosity of a gas suffers very little diminution between atmospheric pressure and an exhaustion at which the green phosphorescence can be detected. When, however, the spectral and other characteristics of the gas begin to disappear, the viscosity also commences to decline, and at an exhaustion at which the green phosphorescence is most brilliant, the viscosity has rapidly sunk to an insignificant amount.

f. The green phosphorescence will not turn a corner in the slightest degree, but radiates from the negative pole in straight lines, casting strong and sharply defined shadows of anything which happens to be in its path. On the other hand, the ordinary luminous phenomena of vacuum tubes will pass along any amount of curves and angles.

Projection of Molecular Shadows.

The author next proceeds to examine the phenomena of shadows cast by the green light. The best and sharpest shadows are cast by flat discs and not by narrow pointed poles; no green light whatever is seen in the shadow, however thin or whatever substance be the material casting it.

From these and other experiments, fully described in the paper, the author ventures to advance the theory that the induction spark actually illuminates the lines of molecular pressure caused by the electrical excitement of the negative pole. The thickness of the dark space is the measure of the mean length of the path between successive collisions of the molecules. The extra velocity with which the molecules rebound from the excited negative pole keep back the more slowly moving molecules which are advancing towards the pole. The fight occurs at the boundary of the dark space, where the luminous margin bears witness to the energy of the collisions of the molecules.

When the exhaustion is sufficiently high for the mean length of path between successive collisions to be greater than the distance between the fly and the glass, the swiftly moving rebounding molecules spend their force, in part or in whole, on the sides of the vessel, and the production of light is the consequence of this sudden arrest of velocity. The light actually proceeds from the glass, and is caused by fluorescence or phosphorescence on its surface. No light is caused by a mica or quartz screen, and the more fluorescent the material the better the luminosity. The author considers that the greenish yellow light is caused by the direct impact of the molecules on the surface of the glass. The shadows are not optical, but are molecular shadows, only they are revealed by an ordinary illuminating effect. The sharpness of the shadow when projected from a wide pole proves them to be molecular.

Phosphorescence of Thin Films.

An experiment is next described in which a film of uranium glass, sufficiently thin to show colours of thin plates, is placed in front of a thick plate of the same glass; the whole being enclosed in a tube with terminals, and exhausted to a few millionths of an atmosphere. With this apparatus the following observations are recorded:—

a. The uranium film, being next to the negative pole, casts a strong shadow on the plate.

b. On making contact with the coil, the thin film flashes out suddenly all over its surface with a yellowish phosphorescence, which, however, instantly disappears. The uncovered part of the plate does not become phosphorescent quite suddenly, but the phosphorescence is permanent as long as the coil is kept at work.

c. With an excessively faint spark the film remains more luminous than the plate, but on making the spark more intense, the luminosity of the film sinks and that of the uncovered part of the plate increases.

d. If a single intense spark be suddenly sent through the tube, the film becomes very luminous whilst the plate remains dark.

These experiments are conclusive against the phosphorescence being caused by the radiation of phosphorogenic ultra-violet light from a thin layer of arrested molecules at the surface of the glass, for were this the cause, the film could under no circumstances be superior to the plate.

The momentary phosphorescence of the film, and its rapid fading out, prove more than this. The molecular bombardment is too much for the thin film. It responds to it at first, but immediately gets heated by the impacts, and then ceases to be luminous. The plate, however, being thick, stands the hammering without getting hot enough to lose its power of phosphorescing.

* "Proc. Roy. Soc.," Nov. 16, 1876, vol. xxv., p. 305.

Mechanical Action of Projected Molecules.

It was noticed that when the coil was first turned on, the thin film was driven back at the moment of becoming phosphorescent, showing that an actual material blow was given by the molecules. Experiments are next described in which this mechanical action is rendered more evident. A small rotating fly, capable of being moved about in any part of an exhausted bulb, is used as an indicator, and by appropriate means the molecular shadow of an aluminium plate is projected along the bulb. When entirely in, or entirely out of the shadow, the indicator scarcely moved, but when immersed so that one-half was exposed to molecular impact the fly rotated with extreme velocity.

Magnetic Deflection of Lines of Molecular Force.

With this apparatus another phenomenon was investigated. It is found that the stream of molecules, whose impact on the glass causes the evolution of light, is very sensitive to magnetic influence, and by bringing one pole of an electro-magnet or even of a small permanent magnet near, the shadow can be twisted to the right or to the left.

The little indicator was placed entirely within the molecular shadow, no movement being produced. An adjacent electro-magnet being now excited, the shadow was twisted half off the indicator, which immediately rotated with great speed.

The Trajectory of Molecules.

The amount of deflection of the stream of molecules forming a shadow is in proportion to the magnetic power employed.

The trajectory of the molecules forming the shadow when under magnetic influence is curved, the action of the magnet is to twist the trajectory of the molecules round in a direction at an angle to their free path, and to a greater extent, as they are nearer the magnet. The direction of twist being that of the electric current passing round the elctro-magnet.

Laws of Magnetic Deflection.

An apparatus was constructed so that the deflection of a spot of light was used instead of that of a shadow; a horseshoe magnet being placed underneath the negative pole to deflect the trajectory. The action of the north pole being to give the line of molecules a spiral twist one way, and that of the south pole being to twist it the other way, the two poles side by side cause the line to move in a straight line up or down along a plane at right angles to the plane of the magnet and a line joining its poles.

The ray of molecules does not obey Ampère's law, as it would were it a perfectly flexible conductor, joining the negative and the positive pole. The molecules are projected from the negative, but the position of the positive pole, whether in front, at the side, or even behind the negative pole, has no influence on their subsequent behaviour, either in causing phosphorescence, producing mechanical effects, or in their magnetic deflection. The magnet only gives their line of path a spiral twist, greater or less according to its power, but diminishing as the molecules get further off.

Numerous experiments were tried in this apparatus with different gases, and with the magnet in and out of position, and the following conclusions are arrived at:—

Working with exhausted air it was found that the spot of green phosphorescence on the screen was visible at an exhaustion of 1026 M when the mean free path of the molecules, measured by the thickness of the dark space round the negative pole was only 12 millims. Hence, it follows, that a sufficient number of molecules to cause green phosphorescence on the screen are projected the whole distance from the pole to the screen, or 102 millims, without being stopped by collisions.

Alteration of Molecular Velocity.

If we suppose the magnet to be permanently in position, and thus to exert a uniform downward pull on the molecules, it is seen that their trajectory is much curved at low exhaustions, and gets flatter as the exhaustion increases. A flatter trajectory corresponds to a higher velocity. This may arise from one of two causes; either the initial impulse given by the negative pole is stronger, or the resisting medium is rarer. The latter is probably the true cause. The molecules which produce a green phosphorescence must be looked upon as in a different state to those which are arrested by frequent collisions. The latter impede the velocity of the free molecules and allow longer time for magnetism to act on them; for, although the deflecting force of magnetism might be expected to increase with the velocity of the molecules, Professor Stokes has pointed out that it would have to increase as the square of the velocity, in order that the deflection should be as great at high as at low velocities.

Comparing the free molecules to cannon balls, the magnetic pull to the earth's gravitation, and the electrical excitation of the negative pole to the explosion of the powder in the gun, the trajectory will be flat when no gravitation acts, and gets curved under the influence of gravitation; it is now also much curved when the ball passes through a dense resisting medium, it is less curved when resisting medium gets rarer; and, as already shown, intensifying the induction spark, equivalent to increasing the charge of powder, gives greater initial velocity, and, therefore, flattens the trajectory. The parallelism is still closer if we compare the evolution of light seen when the shot strikes the target, with the phosphorescence caused in the glass screen by molecular impacts.

Focus of Heat of Molecular Impact.

The author finally describes an apparatus in which he shows that great heat is evolved when the concentrated focus of rays from a nearly hemispherical aluminium cup is deflected sideways by a magnet on to the walls of the glass tube. By using a somewhat larger hemisphere and allowing the negative focus to fall on a strip of platinum foil, the heat rose to the melting point of platinum.

An Ultra-gaseous State of Matter.

The paper concludes with some theoretical speculations on the state in which the matter exists in these highly exhausted vesels. The modern idea of the gaseous state is based upon the supposition that a given space contains millions of millions of molecules in rapid motion in all directions, each having millions of encounters in a second. In such a case, the length of the mean free path of the molecules is excessively small as compared with the dimensions of the vessel, and the properties which constitute the ordinary gaseous state of matter, and which depend upon constant collisons, are observed. But by great rarefaction the free path may be made so long that the hits in a second are negligible in comparison to the misses, and the average molecule is allowed to obey its own motions or laws without interference; and if the mean free path is comparable to the dimensions of the vessel, the properties which constitute gaseity are reduced to a minimum, and the matter becomes exalted to an ultra-gaseous state, in which the new and very decided properties now under investigation come into play.

Rays of Molecular Light.

In speaking of a ray of molecular light, the author

has been guided more by conciseness of expression than by a wish to advance a novel theory. It is considered, however, that the comparison, under these special circumstances, is strictly correct, and that he is as well entitled to speak of a ray of molecular or emissive light when its presence is only detected by the light evolved when it falls on a suitable screen, as he is to speak of a sunbeam in a darkened room as a ray of vibratory or ordinary light when its presence is only to be seen by interposing an opaque body in its path. In both cases the invisible line of force is spoken of as a ray of light, and if custom has made this correct as applied to the undulatory theory, it cannot be wrong to apply the expression to emissive light. The term emissive light must, however, be restricted to the rays between the negative pole and the luminous screen. The light by which the eye then sees the screen is, of course, undulatory.

The phenomena in these exhausted tubes reveal to physical science a new world—a world where matter exists in a fourth state—where the corpuscular theory of light holds good, and where light does not always move in a straight line, but where we can never enter, and with which we must be content to observe and experiment from the outside,

THE SAWYER-MAN ELECTRIC LAMP.

THE practical usefulness of the electric light for illuminating open spaces and wide areas has been amply demonstrated by the various devices for using the electric arc already widely employed. Hitherto, however, it has not been found economical, or even possible, as we understand it, to construct a lamp or candle, based on the electric arc, that would answer the requirements of ordinary domestic and industrial lighting, where a moderate amount of light, well distributed, easily manageable, and of perfect steadiness and softness, is needed. The electric arc seems, from its very nature, to present insuperable obstacles to the economical production of a large number of small lights in a circuit; in other words, such lights as we require in our dwellings, offices, factories, shops, and the like. And if there were no other means of obtaining light from electricity, the probability of the displacement of gas by it, for the purposes of general illumination, would hardly be worth considering.

The production of light through the incandescence of a pencil of carbon or metal, forming part of an electric circuit and highly heated by its internal resistance to the passage of the electric current, offers an entirely different field for exploration; and though it has long been apparently closed by the failure of early attempts to obtain an electric light by such means, the achieved success of Messrs. Sawyer and Man, not to speak of the reported success of Mr. Edison, clearly indicates that this is the line along which the practical solution of the problem of household illumination by electricity is to come. The lamp, to be described further on, lacks only the practical demonstration of its economy by protracted use on a large scale, to compel acceptance as a successful solution of the problem.

So long ago as 1845, an American inventor, Mr. King, patented in America and England a lamp (said to have been invented by J. W. Starr) involving this principle. His light was produced in a vacuum, to prevent the oxidation of his incandescent carbon or metal, and was extremely promising for its beauty, brilliancy, and steadiness. But it failed to be permanent and economical from various defects and deficiencies, some of which have been removed by the increased power and economy of modern dynamo-electric machines, and by recent advances in the art of subdividing the electric current, but the most of them by the inventions and discoveries covered by Messrs. Sawyer and Man's patents.

The economical division of the current, or more correctly the light produced by a single current—popularly believed to be very difficult if not practically impossible—has been successfully worked out by several American investigators. As long ago as 1875, Mr. Moses G. Farmer, now Electrical Superintendent of the U.S. Naval Torpedo Station at Newport, R.I., subdivided the electrical current, produced by a small machine, into forty-two different branches, putting a light to each branch. Mr. Sawyer's system appears to be able to do the same indefinitely through the maintenance of a uniform resistance throughout the circuit and equal resistances in the several parts of the circuit, as will be shown further on.

The light produced is pure, strong, and yet soft, like sunlight. It is, moreover, steady and cool. It is not influenced by air currents, and it does not vitiate the air by poisonous products of combustion, nor by withdrawing the vitalizing oxygen. The lamp takes up less room than the glass shade of a gas jet, and no more than the chimney of an oil lamp. To a limited extent, also, it is portable, and may be used as a drop light. The general appearance of the lamp is shown in fig. 1. The light is produced by the incandescence of the slender pencil of carbon placed as shown in the engraving. The light-giving apparatus is separated from the lower part of the lamp by three diaphragms, to shut off downward heat radiation. The copper standards lower down are so shaped as to have great radiating surface, so that the conduction of heat downward to the mechanism of the base is wholly prevented. The structure of the base, full size, is shown in fig. 1. No detailed description of this portion will be required, further than to say that the electric current enters from below, follows the line of metallic conduction to the incandescent "burner," thence downward, on the other side, connecting with the return circuit. The light-producing portion is, of course, completely insulated, and also sealed at the base, gas-tight.

A fatal defect in all previous lamps depending on incandescent carbon has arisen from what has been called the "vaporizing" of the carbon. This Mr. Sawyer holds to be an absurdity, since the carbon is not even fused. The wasteage of the carbon in mercurial vacuums, and in atmospheres of compound gas, is due, he holds, to chemical decomposition. Many gases, indifferent to carbon at ordinary temperatures attack it destructively at temperatures obtained in the electric lamp; and the process is continuous, the carbon taken from the burner being redeposited on the glass case, and the gas left free to continue its depredation. Mr. Sawyer claims to have overcome this difficulty by his method of charging the lamps with pure nitrogen, and

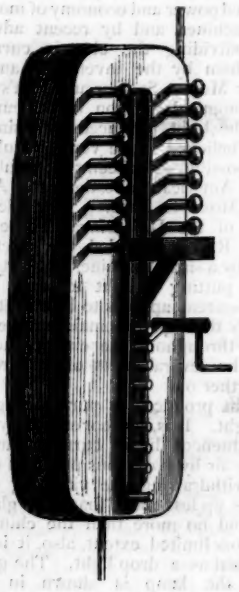
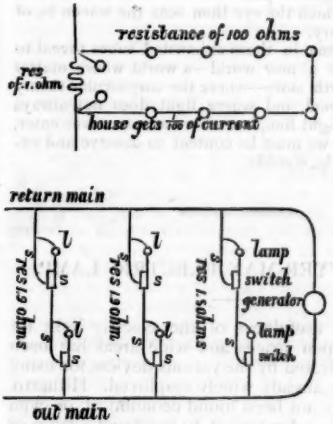


FIG. 2.



FIGS. 4 and 5.

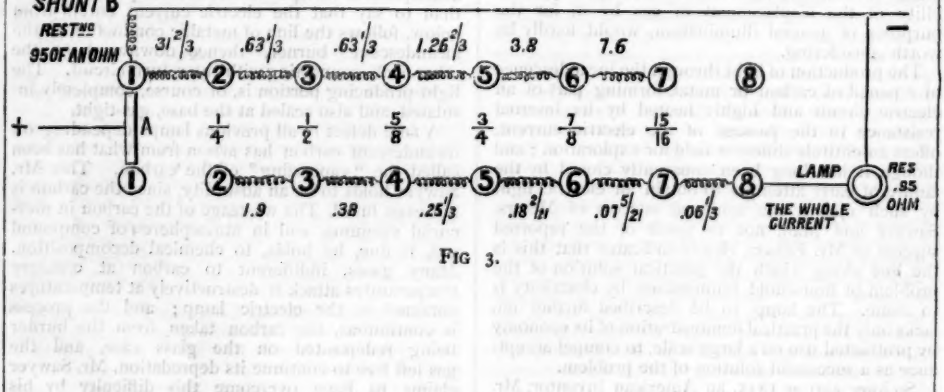


FIG 3.

by providing for the fixing of any residual oxygen left in the lamp. In this way an unwasting carbon is secured. Another stumbling block on which other workers in this field have come to grief, has been the crumbling or disintegration of the carbon burner, due to sudden heating when the lamp is lighted. This is avoided in the Sawyer-Man lamp by an ingeniously devised switch, shown in fig. 2. By this means it is impossible to turn the current on or off suddenly, to the disruption of the carbon. This, however, is not the only nor the chief advantage of the switch. It is, indeed, the key to the entire problem, the indispensable condition, Mr. Sawyer holds, of practical electrical distribution.

It is well known that an electric current will exactly and readily divide among circuits of equal resistance. Accordingly, if the resistance of a sub-circuit be maintained constant, no matter what may be going on in it, whether a lamp is not lighted at all, or lighted in a mere taper, or to any intermediate stage up to full brilliancy, it is obvious that no other lamp or lamps in that circuit will be affected. The operation of the switch, in securing such uniform resistance, is shown in the diagram, fig. 3.

The lamp has, let us say, a resistance of 0·95 of an ohm. Therefore if one lamp is out there should be a resistance of 0·95 of an ohm in its stead. This is the shunt resistance, B. The currents enters at the "+" point, and leaves at the "—" point. The contact piece, A, bearing upon the two studs, 1, 1, all the current passes out by way of B. When A is moved to the studs, 2, 2, the current divides, $\frac{1}{4}$ going through the lamp, the other $\frac{3}{4}$ by way of B, and the resistance of the combined circuit is $0·31\frac{2}{3}+0·95=1·26\frac{2}{3}$ in the shunt; and $1·9+0·38+25\frac{1}{3}+18\frac{9}{19}+0·07\frac{5}{19}+0·06\frac{1}{4}+$(the lamp) $0·95=3·8$. The resistance of the circuit is, therefore, $\frac{1·26\ 2·3\times 3.8}{1·26\ 2·3+3·8}=0·95$ of an ohm, and so on. In short, the resistance of the circuit is constant at 0·95, no matter what may be the change in the proportion of the current given the lamp, as may be seen by making the required calculation for each pair of studs. The varying resistances required to give the best effect have been worked out by practical trial. The effect of $\frac{1}{4}$ the current through the lamp is to make the carbon a dull red. On studs 3, 3, one-half the current passes through, and the carbon becomes a bright red. On studs 4, 4, the lamp gets $\frac{3}{4}$ of the current, and becomes white hot. On 5, 5, the lamp gets $\frac{3}{4}$ of the current, and begins to assume the intense limpid incandescence of the sun; and the light increases rapidly with subsequent changes until the whole current goes through the lamp.

Thus it is seen that the greater part of the illumination is the product of a small part of the current. When the light is well on, a very slight increase in the current increases the light enormously. It is here that the great loss occasioned by dividing a fixed current among several lamps finds its explanation. A current that suffices in one lamp to produce a light, say of 100 candles, will, if divided between two lamps, give in each perhaps no more than 10 candles, or even 5, making a loss of 90 candles in the sum total. But if the current be doubled, each lamp will give a light of 100 candles, and the sum total will be 200 candles

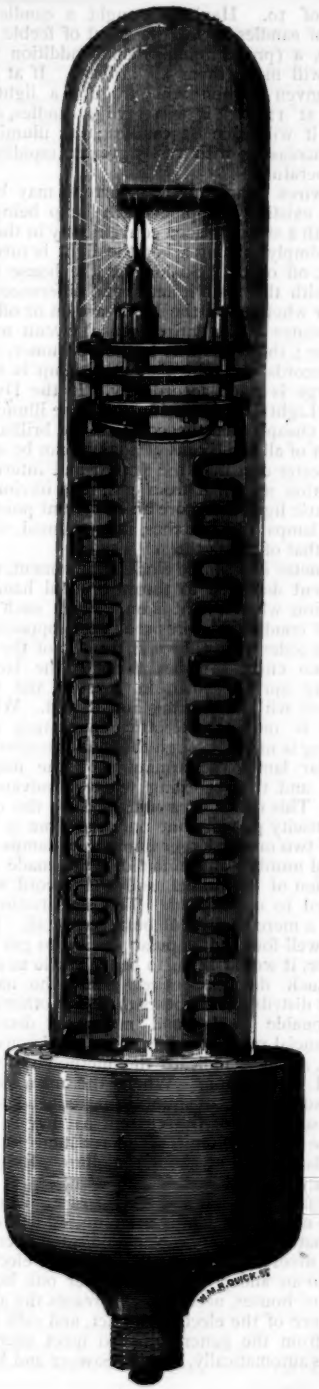


FIG. 1.

instead of 10. Having brought a candle or a system of candles up to the point of feeble incandescence, a (proportionally) small addition to the current will make them all brilliant. If at 6,000°. Fah. a given carbon will produce a light of 3 candles, at 12,000° it will give 9 candles, and at 24,000° it will give 81 candles; the illuminating power increasing with vastly greater rapidity than the temperature.

The wires supplying the current may be run through existing gas pipes, each lamp being provided with a switch placed conveniently in the wall; and by simply turning a key the light is turned up or down, off or on. So long as the house is connected with the main it makes no difference to the producer whether all the lights are on or off, since the resistance of the entire (house) circuit must be overcome; though it will to the consumer, since a meter records the time that each lamp is on, and the charge is rated accordingly. If the Dynamo-Electric Light Company can supply the illuminating force so cheaply that the constant and brilliant illumination of all the rooms of a house can be secured at no greater cost than the partial and intermittent illumination now had from gas, it is obvious that the electric light will score an important point. The cost of lamps and switches, it is claimed, will not exceed that of gas fixtures.

The meter is a simple clock arrangement, with an attachment designed to throw the dial hands into connection when a light is on. From each switch a pair of conducting wires are run to opposite studs on the wooden disc shown at the top of the figure. When no current passes through the lamp the revolving spring shown in front of the studded disc turns without making any record. When the current is on, one electric connection at each revolving is made through the pins assigned to the particular lamp, the armature of the magnet is moved, and the recording wheel is advanced one notch. This meter does not measure the quantity of electricity passing, but only the time a lamp is on. If two or any larger number of lamps are on, an equal number of connections are made at each revolution of the wheel, and the record wheel is advanced to correspond. This registration is, of course, a mere matter of business detail. In view of the well-founded popular dislike to gas meters, however, it would seem to be desirable to dispense with such devices entirely; and the nature of electric distribution appears to favour other and less objectionable modes and means of determining the financial relations of producers and consumers.

Figs. 4 and 5 indicate the method proposed for general distribution. Where the main is tapped for a sub-circuit, a shunt is introduced so as to throw so much of the current as may be needed into the derived circuit. The resistance of say 100 added lamps will be about 100 ohms. By giving to the shunt a resistance of one ohm, $\frac{1}{100}$ of the current will be diverted, and the lamps supplied. When a large number of lamps are required in a circuit, a combination of the two plans indicated is employed.

The diversion of any portion of the electric supply into an added circuit, whether one house or a group of houses, necessarily increases the aggregate resistance of the electric district, and calls for more work from the generator. To meet such contingencies automatically, Messrs. Sawyer and Man have invented and patented a regulator, which responds instantly to any increase or diminution in the demand, thereby securing an absolutely uniform volume of current.

This regulator so controls the steam or other power actuating the generator of electricity, that the amount of power supplied is increased or diminished in exact proportion to the demand, either by changing the volume of steam produced, or by coupling on or detaching different generators or parts of a single generator in circuit.

With regard to the cost of this mode of electric lighting no positive figures can be given. It is claimed to be entirely demonstrated that one horse power will give by the Sawyer-Man system of incandescence a light of 30 five foot gas burners an hour. Where large powers are employed the cost of steam power, every item included, is commonly rated at one cent per horse power per hour. The cost of 150 feet of gas at New York rates is 41 cents, which would make the gas over forty-fold dearer than the Sawyer-Man light. Mr. Sawyer does not stand on this estimate, however, holding that even if the electric light should prove in practice on a large scale to be ten times as costly as calculation indicates, it will yet easily compete with gas, the light furnished being so much better and purer.

It is promised that facilities will soon be offered for the photometric test of a large number of lights, in a circuit, with dynamometric tests of the power employed in generating the electric supply. This, as already noted, is all that the system lacks to prove itself an accomplished economical fact.—*Scientific American.*

[For additional facts as to the cost of the Sawyer-Man light, see our article on "Electric Lighting" in the TELEGRAPHIC JOURNAL for December 1.]

JABLOCHKOFF'S ELECTRIC CANDLE.

WE have on many occasions alluded to the Jablochkoff electric candle, and an illustrated account of it will be found in THE TELEGRAPHIC JOURNAL for the year 1876; but its recent appearance in London on an extensive working scale at the Embankment and the Holborn Viaduct, calls for a description of its very latest developments.

The candle itself consists, as is well known, of two cylindrical sticks of compressed carbon, separated by a strip of insulating material, formerly kaolin, now plaster of Paris, as shown in elevation and cross-section in figs. 1 and 2. These pencils of carbon are each 225 millimetres (8·8 inches) in length, and 4 millimetres (0·157 inches) in diameter, placed 3 millimetres (0·118 inches) apart. Each candle is provided with a conducting tip, composed of powdered plumbago and gum, which is held in its place by a ligature of asbestos. The object of this priming is to start the light when the current is put on and maintain it until the fusion of the plaster of Paris commences, when the latter acts as a partial conductor itself. The lower ends of the carbon stand in sockets of brass, as shown in figs. 2 and 3. One of these sockets or jaws is fixed, and the other (that to the right of fig. 3) is moveable. The left or fixed candle is mounted on a metal base-plate to which the positive pole of the generator is connected by a binding screw. The right or moveable jaw is connected by a metal link to the terminal to which the negative pole

is brought. The moveable jaw is pressed firmly against the candle by means of a curved spring. By this simple arrangement the burnt-out candles may be quickly withdrawn from their sockets and fresh ones installed.

As each candle burns for only 1½ hours, it is necessary to have four candles in each lamp, in order that a continuous light may be obtained for a proper time each night, and that each fresh candle should be automatically

FIG. 1.

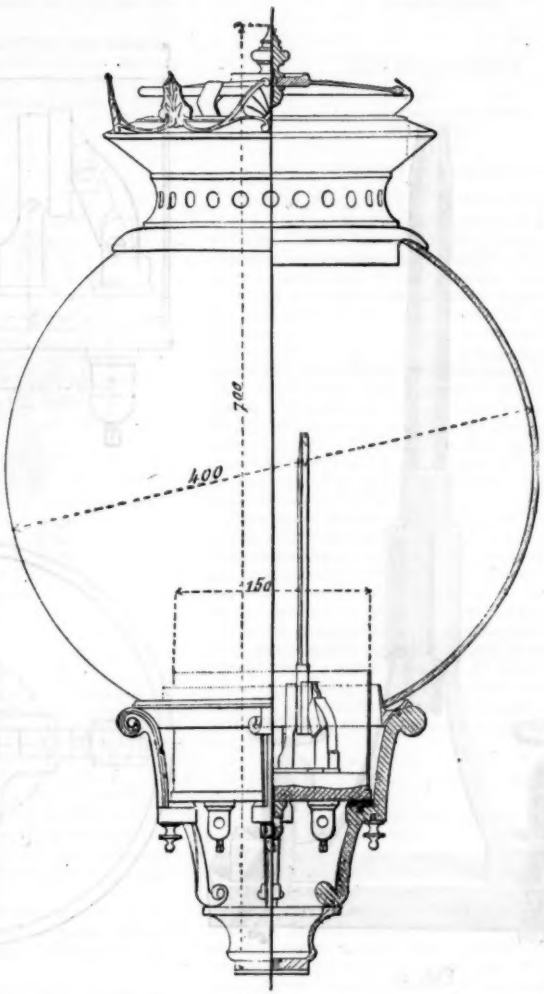


FIG. 3.

lighted in turn when its predecessor has burned down. The four candles are mounted on a circular base of white oynx-stone, which serves to support and insulate them from each other. They are set in the form of a cross, as shewn in fig. 4, and enclosed in an ornamental globe of white opal glass, 16 inches in diameter, and from ¼ to ⅓ inch thick in the material.

The Gramme dynamo-electric machine has always been used in connection with the Jablochkoff candle. Formerly the continuous current Gramme was employed and then the positive carbons required to be twice thicker than the negative, in order that they might consume at the same rate; but now the alternating current Gramme, described in our last issue, is adopted, and the carbons are of equal thickness. Four distinct currents are drawn from each machine, and each of these currents is made to feed four separate candles in series at a time. Four separate lamps are therefore connected in circuit at once for each current; only one candle of each lamp being lit. In the bottom of each lamp, is placed a switch, accessible by a small trap, for turning on the current to each of the four candles in succession. In the ordinary form, operated by hand, a lever connected to the negative pole of the machine is put into contact with one of four studs connected to the

outer or moveable jaws of the candle, while the inner or fixed jaws are connected to the central terminal to which is brought the return wire going to the positive pole of the machine. The switch levers of the four lamps are connected in series, so also are the central terminals. With this switch it is necessary for a man to go round to each lamp and switch on to the next candle; but M. Jablochkoff has obviated this necessity by means of a simple automatic switch, in which the burning of a candle to a certain fixed point frees a platinum detent and releases a spring lever, which makes a contact and instantly diverts the current from the exhausted candle to the next one All four circuits from a machine are connected in this way, and there are, therefore, 16 lamps illuminated at once by the same machine. The conductors are of wire strands of No. 18 B. W. G. tinned copper wire, having a resistance of 1 ohm per 1,400 feet, and insulated with india-rubber. The dimensions in the figures are in millimetres.

Messrs. Wells & Company, Shoreditch, are the agents in London for Jablochkoff's system in London, as the *Société Generalé de l'Eléctricité* are in Paris. In our article on "Electric Lighting," in THE TELEGRAPHIC JOURNAL, for December 1st, we gave the prices quoted by Messrs. Wells & Co. for the supply of this mode of lighting in London; but we may repeat here that probably the whole cost of providing a four-light apparatus including engines, brackets, and the services of a skilled engineer for a short time, to give instructions in its use, would amount to about £400. The cost of the candles is 8d. each, or 5½d per hour. The light from each is estimated as equivalent to 1,000 standard sperm candles when naked, but the opal globes reduce this by 50 or 60 per cent. In calculating the cost of the light as compared with gas, an allowance for interest on capital, and about 10 per cent. for depreciation must be made; but it is obvious that a similar allowance for depreciation should be made in respect to gas fittings.

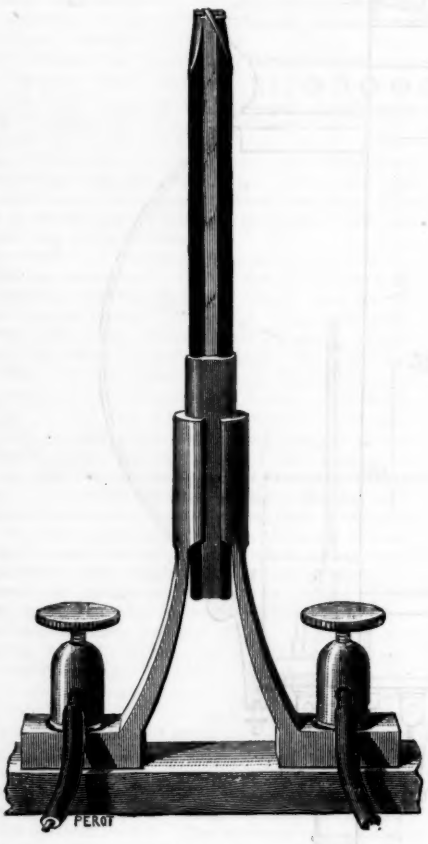
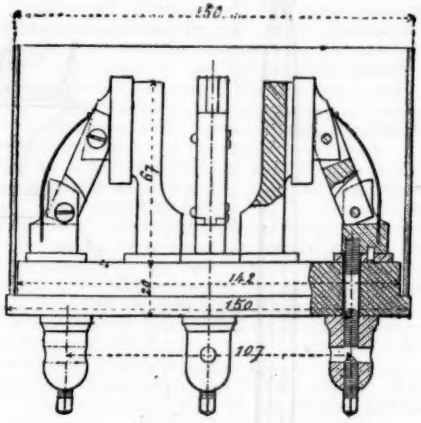


FIG. 2.



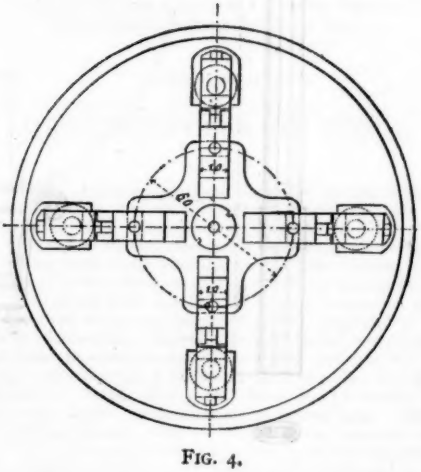
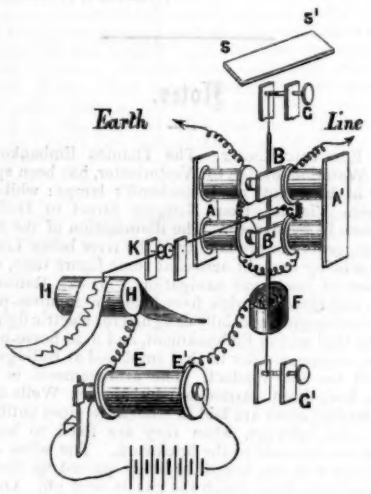


FIG. 4.

AILHAUD'S RECORDER FOR SUBMARINE CABLES.

THE currents employed on submarine lines being very weak, the electro-magnetic force of the receiver is not sufficient to overcome the inertia of the parts usually employed for recording, and more especially the friction of the paper slip against the inker.

We know how Sir William Thomson has obviated this difficulty in the construction of his Siphon Recorder. M. Ailhaud has just devised a small instrument which fulfils the same purpose.



Two electro-magnets A and A' are arranged as shown in the figure; two small magnetic armatures B, B', face the soft iron cores. These are carried by an aluminium wire, terminating below in an iron point, which dips into an iron mercury-cup F. To the centre of this wire, which is kept vertical by cocoon fibres wound upon adjusting screws G, G', is fixed a long slender indicator of aluminium, C. The received current thus deflects the indicator according to the direction in which it passes through the coils.

The recording is effected by the action of an induction spark upon a chemically prepared slip of paper which is carried by a metallic cylinder H, H, below the marking point.

The induction coil furnished with a contact maker, is actuated by a battery of large-surface plates, its ends E, E', being connected, one with the mercury cup, the other with the cylinder H, H. Thus, when the vibrating contact-maker is in action, a sparking is produced between the point and the paper slip; and inasmuch as there is no friction, the movements of the indicator are perfectly free. Two stops, K, which limit the extent of these movements, and a directing magnet S, S', complete the arrangement.

This receiver works very well with a local circuit comprising a Callaud element and ten thousand ohms resistance.

Upon the Marseilles-Algiers cable it is worked with five cells. The chemical paper is impregnated with a solution of potassium iodide and starch.—*Annales Télégraphiques.*

Correspondence.

[We do not hold ourselves responsible for the opinions of our correspondents.

JABLOCHKOFF'S ENGLISH PATENTS.

To the Editor of THE TELEGRAPHIC JOURNAL.

SIR,—Seeing that no one in the recent issues of your valuable journal has offered an opinion respecting the assumed money value of the Jablochkoff electric candle patent, mentioned in a previous number, I have ventured to submit the following remarks thereon for the consideration of your readers. The provisional specification was taken out in the name of Mr. R Applegarth, in 1876, and is said to be a communication from "Paul Jablochkoff, of 3, Boulevard Voltaire, Paris." This specification has become "void," as you have stated, "by reason of the patentee having neglected to file a specification in pursuance of the conditions of the letters patent." The question now is, did this lapsed specification claim all the details of the said candle as we now understand it? I think it did; but let the specification speak for itself.

Everyone knows that great stress has been laid on the fact that the Jablochkoff system got rid of the automatous element common to other electric lamps, therefore he will not be surprised to find the specification leading off as follows: "This invention consists of the entire removal of all the mechanism generally used inside electric lamps. Instead of causing the carbon points to approach each other automatically by machinery in proportion as they are consumed, I place them side by side," . . . . "but I place an isolating substance between them, which consumes at the same time as the carbon points; for instance, porcelain, brick, magnesia, or any other isolating substance."

"The carbons used by me may be,—

"1. The ordinary carbon points used for the purpose of electric light.

"2. Hollow carbons of different sizes to admit of one being placed inside the other.

"3. Carbons made of compressed coal, which are well suited to the tube arrangement before mentioned.

"The two carbons thus prepared, are fixed in a stand, which may be described as a special candle-stick, and a current of electricity by means of a battery, or any other source, is passed through them. To light the lamp, I join the tips of the carbons by a small slip of carbon, which, on the electric current passing through, produces light. To prevent one of the carbons consuming more rapidly than the other, I use carbons of different thicknesses to ensure equal consumption of both. I can either place between the two carbon points a piece of the isolating substance or I can place one or both of the carbon points in an isolating tube or tubes."

He also claims to utilize a part of the electric current to put in motion or stop clock work for the purpose of raising or lowering the carbon points, if it be required to keep the light at any particular spot, "for instance, the centre of a reflector,"

Also "the right to produce a coloured light by mixing colouring matter with the isolating substance which separates the carbons." After this I think that no one who has seen the candle and its application will for a moment doubt that whatever value it may be as one of the "new lights," it cannot be of much money value as a patent right after the lapse of so clear a description with drawings. If the patent taken out in his own name in 1877 was intended to redeem the loss, I am of opinion that it will not do so, for if this specification be read in connection with Applegarth's, it will be seen to have reference to the means for holding or setting up the candles than to any improvement or modification, of any value, as regards the construction of the article in question. For instance, he suggests a powder as an insulator instead of a solid substance, which is made clear by saying that "A powder which I find serviceable consists of one part of lime, four parts of sand, and two parts of talc." He then proceeds to say that the candle is made by placing the two carbon rods parallel to each other in a case or cartridge made of asbestos, card, or paper, and the space within surrounding the rods filled in with powder similar to the above-mentioned. Finally, were are told that the construction of the candle may be varied, that is, instead of the carbons being square in section they may be round, and instead of being contained in a cartridge, "merely separated by a partition of kaolin, or other similar insulating material." Here, you see, we are brought back to the first idea of placing "an isolating substance between them," (the carbons), "which consumes at the same time as the carbon points, for instance, porcelain, &c."

After the experiments of Mr. Henry Wilde in connection with the Jablochkoff candle, it will not be out of place to refer to Mr. Werdermann's patent of 1874 as showing that he was the first to arrange the carbons side by side for the production of the voltaic arc, and that too without any isolating material between them, for the purpose of producing light and heat at their points. He says, "The carbon points of the electric light are fixed in a suitable handle or frame provided with pinions and racks to regulate their distance." He then explains how he converts the arrangement during the passage of the current from one carbon to the other into a powerful blow-pipe. There is no mention here of any insulator, notwithstanding the carbons are near enough to allow the voltaic arc to form, and that too only at their points. The fact that carbons mounted as proposed by Werdermann, will burn from their tops downwards until consumed, has been fully confirmed by Mr. Wilde. In fact, his experiments go to prove that the insulator is more harm than good, for we read that "the light from the naked carbons was also more regular than that from the insulated ones." In fine, Mr. Wilde's experiments go to prove that the insulating material is mere damage, and has nothing to do with the conduction of the current when fused, nor the improvement of the light. In conclusion, allow me to add that since our eyes have been opened by Mr. Wilde's experiments, it is easy to see that if the current would pass from one carbon to the other, if not debarred, there need be no carbon slip connecting their tips for the purpose of lighting the candle, as the tips are always clear of the insulating partition.

W. MANN.

THE SOURCE OF SOUND IN THE TELEPHONE.

SIR,—I have read with great pleasure, in the last three numbers of your journal, the articles of the learned Prof. D. E. Hughes upon the origin of sound in the telephone. The experiments made and described by Mr. Hughes complete and confirm those which I have executed to prove that in *the Bell telephone the source* of useful sounds lies in the movement of the diaphragm.

I am the happier to find myself at last in accord with Mr. Hughes, because that accord is the result of experiments conscientiously made and loyally interpreted by both.

Receive, sir, the assurances of my most distinguished consideration.

Echaerbeck, Brussels. NAVEZ.

POSTAL TELEGRAPH SERVICE.

SIR,—Can any of your numerous readers give me a reason for the alteration recently made in our official designation? Originally we were styled "Telegraph Clerks." We are now reduced or promoted—I know not which—to "Telegraphists." I have heard murmurs that the alteration is intended to deprive us of some of the benefits secured by the Playfair commission. While disbelieving this, I should still be glad to hear the explanation for the change.

TELEGRAPH CLERK.

Notes.

THE ELECTRIC LIGHT.—The Thames Embankment, from Waterloo Bridge to Westminster, has been splendidly lit by twenty of Jablochkoff's lamps: while the Holborn Viaduct, from Newgate Street to Holborn, has been lit by sixteen. The illumination of the river-side suggests the probability of the river below London Bridge being lit right across at some future time, so as to allow of nocturnal navigation. Messrs. Ransomes, Sims, and Head, Ipswich, have loaned a 20 horse-power (nominal) engine, specially designed for electric lighting, for the trial on the Embankment, and a 20 horse-power Robey engine, similar to that employed at Billingsgate, is used for the Viaduct. The arrangements in both cases have been carried out by Messrs. Wells & Co. The leading wires are laid in stoneware pipes until they reach the subways, when they are fixed to boards, which are fastened to the brickwork. The wires communicate with the lamps by being passed up through the gas tubes from which the gas is shut off. On the Embankment the alternate gas lamps are fitted with four candles, so that there is a distance of 40 yards between each pair of lamps. The greatest distance between one lamp and the generator on the Westminster side is 700 yards, and 470 yards on the Waterloo side. The photometric power of a lamp will be ascertained by comparison with the 16-candle oil-lamp of Mr. Keates; but the naked light is reckoned at 1,000 candles, therefore as intensity of light diminishes inversely as the square of the distance, the naked candle at 48 feet distance should equal the Keates' lamp at 6 feet distance. A single Gramme's alternating machine is used in both places. These trials are respectively inaugurated by the Metropolitan Board of Works and the City Commissioners of Sewers to get at the true cost and feasibility of Jablochkoff's system.

EDISON'S ENGLISH PATENT FOR THE ELECTRIC LIGHT.—The opposition to Mr. Edison's application for patent No. 4226, dated October 23, 1878, for "Improvements in the method of and means for developing electric currents and lighting by electricity," was heard on the 16th ult., before the Solicitor-General, in his private room at the House of Commons. The opposed and the opposer were both represented by counsel, Mr. Theodore Aston, Q.C., instructed by Messrs. Brewer and Jensen, patent agents, 33, Chancery-lane, appearing on behalf of Thomas Alva Edison, and Mr. Goodeve for John Huddart Russell. The grounds

of objection lodged were that Edison was not the true and first inventor of the said improvements, or of some of them. The objector, although he had the opportunity given him of doing so, had not lodged any evidence in support of his objection. This is a somewhat unusual proceeding in these opposition cases, as the objector usually wishes to support his reasons for objection by evidence, showing for example, that a patent or manufacture in which he is interested, would by the grant of the application for the patent in question be prejudiced. The interpretation of the Patent Law on the subject of these oppositions is rather peculiar. For instance, it appears that any one who likes may oppose, without showing that he has any apparent *locus standi*, and without giving any security for costs or damages. At the hearing of this case it was stated that Mr. Russell had a pecuniary interest in a patent granted to M. Arnaud. The reason why this gentleman's name was not disclosed earlier appears due to the fact that his patent was not sealed until the 14th ult. M. Arnaud is now looked upon as the real opponent of Mr. Edison, in the case, and had this been known earlier, there is no doubt that M. Arnaud's application for a patent would have been opposed on the part of Mr. Edison. The result of the first day's proceedings was that Mr. Russell was ordered to pay costs of the hearing, and the further hearing of the case was adjourned for a few days, to enable Mr. Russell to produce the evidence which should have been lodged in the first instance. The public must therefore wait yet longer before Mr. Edison's invention can be placed before them. At the adjourned hearing of the case, Mr. Russell's evidence was supplied by Messrs. Russell, Haddon and Knowles, and replied to by Messrs. Adams and Walenn. The decision was to the effect that Mr. Edison's patent should be allowed to proceed and that Mr. Russell should pay all costs incurred.

EDISON'S electric light has been patented in Brazil and other parts of South America, and the firm of Fabri and Chancery have purchased the patent rights for South America. The total cost of his patents is said to be £3,500 thus far, and £20,000 is to be spent on experiments. He expects to get six lights, each equal to a gas jet, from each horse-power of the new dynamo-electric machines.

M. CARRÉ, the carbon electrode maker, is manufacturing 2,000 metres of rod per day, and is extending his works.

A NEW electric lamp, with four carbon rods, arranged parallel, for the electro-pyres is to be tried shortly in Paris.

J. W. STARR, the inventor of electric lighting by incandescence, as patented by King, in England, in 1845, was a very talented young philosophical instrument maker of Cincinnati. He came to England with Mr. King, his agent. Mr. Peabody, the well-known philanthropist agreed to furnish capital to float his invention. Starr constructed a cluster of his lights, enclosed in globes of glass, twenty-six in number, so as to represent the States of the Union. This "United States' Tree," as it was called, excited the admiration of Faraday, and after the exhibition King and Starr went home elated with success. Next morning Starr failed to appear at breakfast, and afterwards was found dead in his bed from over excitement. Nothing further was done with his invention. Starr's caveat, filed in America, claims the use of continuous metallic and carbon conductors for the production of the electric light, "the current being regulated so as to obtain the highest degree of heat without fusing the conductor." Starr's application was rejected in America in 1846, on the ground that his invention was not new. Mr. Edison states that his plan is different from Starr's.

MR. FAHRIG, electrician, Southampton, has, it is said, invented a compound which gives off more light and less heat than carbon under the action of the electric current, and can be made either rigid or flexible.

IN a recent paper in the *Chemiker Zeitung*, Dr. Werner Siemens stated that recently at Bremen a ship with an electric light on her prow, sailed down the river at full speed in the night; and that the Imperial dockyards at Keil are now lit by Jablochkoff's candles.

M. S. MARCUS, of Vienna, is said to have subdivided the electric light before Edison announced his discovery. We rather want to see some of these many reputed subdivisions.

IT has been decided to extend the Jablochkoff electric light to other thoroughfares of Paris, a reduction in the cost having been arrived at.

THE capital of Washington is to be lit electrically by a form of lamp invented by Mr. Rogers, the electrician of the Capitol, which is almost the same as that of Rapieff. It is expected that four dynamo-machines will serve to supplant the 1,300 gas jets now employed.

THE City Commissioners of Sewers, London, have decided to accept the offer of the Gas Light and Coke company to light the London gas lamps at the old rate of 18s. for each ordinary lamp, and 22s. 3d. for each circular lamp, during 1879.

THE electric light was experimentally used at the London Bridge terminus of the London Brighton and South Coast Railway on the evening of Saturday the 21st ult., for lighting the open space between the Main Line and Crystal Palace Line booking offices and the platform barriers. The ordinary Gramme machine and Suisse lamp were employed, the motive power being obtained from an engine some 250 yards distant, which, in addition to working the magneto machine, also pumped up the water required for the general purposes of the station. The machine is the first of its kind made in England, and, together with the lamp, which is said to last about twelve hours without attendance, was supplied by the India Rubber and Telegraph Works Company, of Silvertown, whose electrician, Mr. R. K. Gray, and the railway company's telegraph engineer, Mr. E. J. Houghton, assisted by Mr. Carey, carried out the experiment.

THE INVENTION OF THE TELEPHONE.—*Apropos* of the attempt being made to deprive Professor Bell of the honour of inventing the speaking telephone, we observe in *Nature* a letter from Mr. J. C. Watson, one of the English jurors at the Philadelphia Exhibition, who examined the telephones there exhibited. Mr. Watson describes how he and Sir William Thomson heard Mr. Gray explain his harmonic telephones in chronological order on June 18 (or 25), and on the same day spoke through the speaking telephone of Professor Bell. Mr. Watson further says, "The news of these successful experiments (with Bell's telephone) soon circulated freely, and the day following, or possibly two days afterwards, Mr. Gray came to me and inquired whether the reports of our success with Bell's telephone were correct; and upon receiving from me an affirmative reply, he said that it was impossible, that we had been deceived in some way, that the transmission was by actual metallic contact

through the wire, and that it was, to use his own words, 'nothing more than the old lover's telegraph.' In reply, I said to him that we had taken every possible precaution against error, that we were both convinced of the reality of Bell's claims, and that Sir William Thomson would report to that effect. He persisted in his statement that the result was impossible, and that we must have been deceived in some way or other. After having had direct knowledge of Mr. Gray's views at that time, I must confess to some astonishment at his claim now made that he anticipated Mr. Bell in the invention of the speaking telephone."

ELISHA GRAY had an immense entertainment in his honour at Chicago the other evening. Telephonic music, telephonic speeches, telephonic songs, telephonic poetry, and telephonic toasts. Big time. Congratulated as being the first and only inventor of the telephone. So was Bell when they gave him a banquet; so was Edison when he had his free lunch. So was Dalbear. So was——By-the-way, who *did* invent the telephone?—*Detroit Free Press*, U.S.

A NEW TELEPHONE.—In the *Comptes Rendus* for Nov. 18, M. C. Ader describes a telephone receiver which gives out sounds audible to a number of by-standers. It consists of a tambour having a diaphragm of parchment paper 15 centimetres in diameter. To the centre of this diaphragm are cemented circularly, six small pieces of tinned iron, each 1 centimetre long by 2 millimetres broad. These armatures are acted on by six small horseshoe electro-magnets, the cores of which are not more than 1 millimetre in diameter, and the limbs are about 6 millimetres in length, with coils in proportion. All these electro-magnets are connected in series, and the line current is passed through them. This current is supplied by a speaking microphone transmitter and three Leclanché cells. M. Ader calls his instrument an *electro-phone*.

"LA FLUTE TELEPHONIQUE."—Our artistic neighbours across the Channel have recently been amusing themselves with a "singing condenser," and now they are performing upon another musical curiosity in the shape of a "telephonic flute." This *petite merveille* is being exhibited at the *Musée Polyphonique*, a new museum established in Paris by M. Delaporte for all kinds of telephones, microphones, and phonographs. This flute, says an enthusiastic writer in *La Correspondence Scientifique*, is one of the most curious instruments that we have heard for a long time. And, God knows, if we are not beginning to accustom ourselves to extraordinary things! Picture to yourself an ordinary flute, furnished near its mouth with a kind of box, intended to hide the secret—a secret which we cannot now reveal. The flutist began the execution of a *morceau de flute*, and then by a simple movement of the thumb of the left hand, without displacement or transition, the sounds of the flute were changed into others quite as harmonious and correct as those of the flute, but which had not the least resemblance to them. They were sounds whose timbre was similar to that of the hautboy, or rather to a cross between the hautboy and the clarionet. With the flute we got the same intonations, the same varied shades, as with the complete instrument. *C'est charmant!*

THE GYMNOTUS AND THE TELEPHONE.—The electric discharge of the gymnotus, or electric eel, has recently been the subject of investigation by M. Marey, a French *savant*, who has demonstrated that it is made up of a series of discharges very like those of the living torpedo. It occurred to M. Marey to employ the telephone in studying the periodicity of these discharges. He therefore placed a healthy torpedo between two sheets of tinfoil connected in circuit with a telephone; and on pricking the electric lobe of the animal, he heard in the telephone a kind of prolonged moan, of which he estimated the pitch. It was that of *me* in the tonic scale, corresponding to 330 vibrations per second. The ordinary discharge of the torpedo is too brief to give any other sound than a crack.

"THE VOICE OF THE EARTHQUAKE."—Some time ago we suggested to Prof. Palmieri the use of the microphone in connection with a seismograph to render the vibrations of the earth at Vesuvius audible; and now we hear that the learned Professor has adopted the plan. In a recent note to the Italian journal *Roma* he says, "The seismograph permits an attentive observer to note the vibrations of the ground; by aid of a microphone transmitter and a telephone receiver, the ear can now perceive the noise of these vibrations. I have verified this fact in June last with a microphone sent by M. Pugnetti, inspector of telegraphs at Rome. The microphone is then a precious auxiliary to the seismograph. Professor Michel-Etrenne de Rossi, with a microphonic apparatus much more delicate, has made surprising experiments on this subject in his observatory at Vesuvius. His results will be made known in a periodical called *The Italian Vulcan*. Professor Rossi has been able at each manifestation of an irruption in Vesuvius to hear, so to speak, the palpitation of the earth."

THE MICROPHONE AND THE SPIRITS.—Professor Palmieri's success in hearing the "voice of the earth," suggests to us that it might also be used as an aid to those lay utterances of the unseen universe commonly called spirit rapping. Professor Hughes has investigated the source of sound in the telephone by its means. Why not also investigate the source of sound in the table? A skilfully concealed microphone might help to solve that vexed question of the authenticity of spiritualism. We recommend it to the use of those enquiring *savants* and Russian barons who wish to fathom that interesting mystery.

M. VAREY'S form of transmitting microphone which was recently tried with much success between Paris and Versailles, has also been tried by Major Webber in this country, over sixty miles of wire. Although there was a considerable induction noise on the wire the microphonic voice could, we believe, be distinctly heard. Varey's form consists of a pencil microphone in circuit with the primary of an induction coil, the secondary being in circuit with the line.

"*Le Microphone et ses Applications en Medicine*," by Dr. Gibours, is the title of a pamphlet just published by Balliere & Sons, Paris.

M. BREGUET, the well-known electrician; M. Grandeau, the physicist, whose recent researches on the influence of electricity on vegetation we summed up in the TELEGRAPHIC JOURNAL for September 15, 1878; M. Menier, the chocolate and cable manufacturer, and M. Gauthier-Villars, formerly inspector of telegraph lines, now librarian of the Bureau of Longitudes, have been made Officers of the Legion of Honour; while M. Deleuil, mechanician; M. Dunod, editor of the *Annales Telegraphique*; M. Thomasset, constructor of telegraphic testing instruments; M. Bontemps, chief of the Parisian pneumatic system, and M. Baudot, inventor of the Baudot multiple apparatus, have been created Chevaliers of the same Order. M. Jablochkoff

was awarded a gold medal for his system of electric lighting.

THE "SINGING CONDENSER" has recently re-appeared at Paris, where it is generally introduced as an invention of Mr. C. Varley instead of Dr. Wright. In a description of Reiss' receiving telephone, given in 1867 in Ferguson's *Electricity*, the following passage occurs:—"Suppose a person to sing a note at the mouthpiece which produces 300 vibrations a second, the circuit is broken at the bladder 300 times, and the iron wire ticking at this rate gives out a note of the same pitch. The note is weak, and in quality resembles the sound of a toy trumpet. Dr. Wright uses a receiving apparatus of the following kind:—The line current is made to pass through the primary coil of a small induction coil. In the secondary circuit he places two sheets of paper, silvered on one side, back to back, so as to act as a condenser. Each current that comes from the sending apparatus produces a current in the secondary circuit, which changes and discharges the condenser, each discharge being accompanied by a sound like the sharp tap of a small hammer. The musical notes are rendered by these electric discharges, and are loud enough to be heard in a large hall."

This was the last word on telephony in 1867. Nine years later the speaking telephone was invented, and we hear a great deal on the subject to-day; but yet they had done something then which should not be overlooked.

"*The Exchange Telegraph Recorder*."—This novel publication has been started by the Exchange Telegraph Company in order to supply those outside the radius of the company's telegraph system who are interested in the prices of stocks and shares, with a continuous reliable daily record of the fluctuations on the London Stock Exchange. The prices quoted are those obtained in the various markets by the company's special reporters, for telegraphic and transmission over the company's lines. In addition to the daily fluctuation on the London Stock Exchange, all other current prices passing over the company's system will be given.

M. LIAIS, director of the Rio de Janeiro Observatory, has begun to determine the longitude of Rio, west of Greenwich, by means of the telegraph.

SCHELLEN, the well-known author of a German work on telegraphy, has recently published one on the Electric Light.

WE regret to have to record the death by violence, of a promising young telegraphist, Mr. William Anderson, at Canea, in the Island of Crete, on the evening of the 14th ult. Mr. Anderson was the superintendent of the Eastern Telegraph Company at that place. He was a nephew of Sir James Anderson, managing director of that company, and was much respected and esteemed by all classes and creeds. His remains were found outside the city gates along with those of a native clerk with whom he had been walking. The murderers have not yet been traced, but Her Majesty's Consul, Mr. Sandwith has proceeded to Canea to investigate the outrage.

New Patents.

5041. "Thermo-electric piles and generators." J. M. E. LUDRE. Dated Dec. 9.

5076. "Electro-magnetic and magneto-electric machine." J. H. JOHNSON (communicated by E. Bertin and F. E. de Mersanne). Dated Dec. 11.

5093. "Improving apparatus for composing, transmitting and deciphering secret telegrams." H. J. HADDAN (communicated by Schacher et Cie.). Dated Dec. 12.

5139. "Apparatus for the production and application of electricity for lighting and other purposes." W. B. BRAM. Dated Dec. 14.

5152. "Improvements in electric lamps or lights, and in the electrodes, and appliances connected therewith. G. WHYTE. Dated Dec. 16.

5165. "Electric lamps." A. M. CLARK (communicated by L. Reynard). Dated Dec. 16.

5181. "Construction and working of telephones and apparatus connected therewith." C. J. WOLLASTON A. SCOTT. Dated Dec. 17.

5183. "Improvements in and relating to electric lighting apparatus." W. R. LAKE (communicated by J. B. Fuller). Dated Dec. 17.

5197. "Producing and regulating electric light." H. WILDE. Dated Dec. 18.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

902. "Transmitting light." M. T. NEALE. Dated March 5, 1878. 6d. This consists in a means of distributing the light from an electric lamp, or other powerful source, to different places by means of pipes and reflectors of non-absorbent material. The interior of the pipes and reflectors should be enamelled, glazed, or coated with reflecting metals. Main and branch pipes are employed.

1079. "Telephonic apparatus." A. BREGUET, CORNELIUS ROOSEVELT, and GABRIEL LIPPMANN, Paris. Dated May 28, 1878. 6d. This describes Breguet's electro-capillary telephone, in which the voice imparts motion to contact surfaces of mercury and dilute sulphuric acid, thereby producing corresponding currents of electricity which travel along the line, and reproduce the sounds on a similar apparatus at the distant end. See TELEGRAPHIC JOURNAL for April 15, 1878.

1155. "Telegraphs." R. THEILER, J. E. THEILER, and MEINRAD THEILER. Dated March 23, 1878. 6d. This consists in multiplying the mechanical effect of telegraph or other electric currents by means of air or other gaseous pressure. The pressure may be applied as a continuous blast, whose intensity is controlled by causing the electric current to regulate the orifice, or it may be applied by causing the current to vary the pressure in an enclosed chamber by regulating the outlet. The motion is obtained by means of an elastic diaphragm forming a side of the chamber, and rising or sinking with the air pressure inside. Instead of providing an outlet for the gas, two diaphragms of suitable relative proportion may be used. By moving one of these under the action of the current the other will respond and actuate the recording pen, which may be a siphon, stylus, or an ordinary Morse marker.

The patent also includes a key, which instead of sending currents of unequal duration, and spacing them equally, sends equal short currents and spaces them unequally. The rocking lever of this key may be of the usual shape, and its movement limited in the usual way by a contact stud in front and another at the back. This motion is magnified by additional suitable leverage, and transmitted to a contact-maker. To this contact-maker a click and a suitable grinding piece are attached, which allow it to move only in a certain line when going downwards, and force it to move in another line when going back. This contact-maker therefore rubs one contact in going down, and a different one in going up. But before changing from one contact to the other it touches neither of the two, and the circuit is consequently broken by suitable connections with the line, earth, and battery; this key will therefore send a current of one polarity going down, and one of the opposite polarity going up.

1195. "Electric conductors." H. C. SPALDING, New Jersey. Dated March 26, 1878. 2d. This consists in

the employment of conducting liquids, enclosed in suitable non-conducting tubes, as conductors of electricity. *Not proceeded with.*

1196. "Electric conductors." H. C. SPALDING, New Jersey. Dated March 26, 1878. 6d. This consists in employing thin strips of metal conductors, enclosed in insulating tubes or coatings of enamel or glass.

1228. "Electric telegraphs." HENRY WILDE. Dated March 28, 1878. 6d. This consists in generating simultaneously a number of separate line currents by causing the alternating currents from a dynamo-electric machine to traverse the coils of a number of small electro-magnets which experience reversals of their magnetisation simultaneously with the reversals of the magnetism of the armature of the machine, and intense secondary currents are generated in secondary wires surrounding these magnets. The alternating currents from these secondary coils are made to give audible signals by a Morse key, in the manner described by the patentee in patent 3196, of 1869. The patent also describes a dynamo-electric generator, which consists of a Pacinotti armature (which consists of a broad and thick ring of iron, recessed at equal angular distances round its periphery for the reception of coils of insulated wire), surrounded with a circle of inducing electro-magnets placed at equal angular distances from each other. The circle is formed of an even number of magnets corresponding to the number of coils in the armature, having N. and S. poles alternately. Part of the armature coils feed the external electro-magnets and part perform the external work.

1248. "Insulators for telegraph purposes." JOSEPH OPPENHEIMER. Dated March 29, 1878. 4d. This consists in protecting insulators from the destructive effects of lightning by fitting a lightning discharger within the insulator itself. For this purpose, the iron bolt of the insulator is made to present a pointed metal discharger to the underside of the top of the iron hood of the bell. The bell is open at the top for this purpose. The discharge takes place between the hood and the point, and thence reaches earth by the bolt and the lightning rod of the post.

City Notes.

Old Broad Street, Dec. 30th, 1878.

The Eastern Telegraph Company (Limited) announce the payment of an interim dividend of 2s. 6d. per share on the ordinary shares of the company, free of income tax, on the 14th January, in respect of profits for the quarter ending 30th September, 1878, and that a dividend of 3s. per share on the preference shares, less income tax, for the quarter ended 31st December, 1878, will be paid on the same date.

The directors of the Eastern Extension Telegraph Company (Limited), have declared an interim dividend for the quarter ending 30th September last of 2s. 6d. per share, or at the rate of 5 per cent. per annum free of income tax, payable on the 15th January.

On the 23rd ult., the Western and Brazilian Telegraph Company (Limited), notified that their Cable between Pernambuco and Bahia, was repaired, thus restoring direct communication by cable between Pernambuco, Rio Janeiro, Uruguay, the Argentine Republic, Chili, and Peru.

The *Times* reports that the Franco-American cable scheme is now to be brought forward.

The following are the latest quotations of telegraphs:—Anglo-American, Limited, 56⅛-57½; Ditto, Preferred, 82½-83½; Ditto, Deferred, 31-32; Black Sea, Limited, —; Brazilian Submarine, Limited, 6⅜-6⅝; Cuba, Limited, 8¼-8⅜; Cuba, Limited, 10 per cent. Preference, 15-15½; Direct Spanish, Limited, 1⅝-2⅛; Direct Spanish, 10 per cent. Preference, 9½-10; Direct United States Cable, Limited, 1877, 11¼-11½; Eastern, Limited, 7⅛-7⅜; Eastern, 6 per cent. Debentures repayable October, 1883, 102-105; Eastern 5 per cent. Debentures repayable August, 1887, 100-103; Eastern, 6 per cent. Preference, 10⅞-11; Eastern Extension, Australasian and China Limited, 6⅛-7⅛; Eastern Extension, 6 per cent. Debenture, repayable February, 1891, 103-105; German Union Telegraph and Trust, 8-8⅛; Globe Telegraph and Trust, Limited, 4⅜-5; Globe, 6 per cent. Preference, 10⅛-10⅜; Great Northern, 7⅛-8⅛; Indo-European, Limited, 19-20; Mediterranean Extension, Limited, 2½-3; Mediterranean Extension, 8 per cent. Preference, 8⅞-9½; Reuter's, Limited, 9½-10½; Submarine, 215-220; Submarine Scrip, 1⅝-2; West India and Panama, Limited, 1⅛-2⅛; Ditto, 6 per cent. First Preference, 7⅞-8¼; Ditto, ditto, Second Preference, 7⅞-8¼; Western and Brazilian, Limited, 2¼-2⅜; Ditto, 6 per cent. Debentures "A," 87-92, Ditto, ditto, ditto, "B," 84-88; Western Union of U. S. 7 per cent., 1 Mortgage (Building) Bonds; 114-118; Ditto, 6 per cent. Sterling Bonds, 100-102; Telegraph Construction and Maintenance, Limited, 28½-29½; Ditto, 6 per cent. Bonds, 100-103; Ditto, Second Bonus Trust Certificates, 2⅞-2⅞; India Rubber Co.,—.

TRAFFIC RECEIPTS.

Name of Co., with amount of issued capital, exclusive of preference and debenture stocks.	Anglo-American Co. £7,000,000.	Brazilian Sub. Co. £1,300,000.	Cuba Sub. Co. £160,000.	Direct Spanish Co. £116,379.	Direct U.S. Co. £1,108,420.	Eastern Co. £3,697,000.	Eastern Ex. Co. £1,997,500.	Gt. Northern Co. £1,500,000.	Indo-Euro. Co. £425,000.	Submarine Co. £338,235.	West Coast America Co. £300,000.	Western and Brazilian Co. £1,398,200	West India Co. £883,210.
	£	£	£	£	£	£	£	£	£	£	£	£	£
November, 1878	51,090	12,753	2,600	1,002	17,030*	37,170	25,280	16,587	... ...	9,549	2,200	... ...	4,676
November, 1877...	47,890	12,233	2,859	885	12,920	38,439	20,794	18,206	... ...	9,817	1,800	10,368	4,292
Increase	3,200	520	... ...	117	4,110	... ...	4,486	... ...	... ...	... ...	400	... ...	384
Decrease	... ...	... ...	259	... ...	... ...	1,269	... ...	1,619	... ...	268	... ...	... ...	... ...

* Estimated *b* Not published.

(The figures in this Table are as accurate as it is in our power to make them, but we do not guarantee their correctness.)